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EFFECTS OF DWARF MISTLETOE IN SHELTERWOOD UNITS ON THE MINARETS RANGER DISTRICT, SIERRA NATIONAL FOREST

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Background

Two shelterwood units on the Minarets Ranger District were visited on June 19, 1997. Those present included: Chris Nota, Dave Smith and Ross Peckinpah - Minarets District; Dick Kunstman - Audobon Society; Bob Hrubes - Natural Resource Associates; and myself.

One mangement objective for the site is to produce a stand with characteristics favorable for the California spotted owl within a timeframe as short as practical. While fiber production is not an objective, optimizing tree vigor and height growth would shorten the time required to attain owl strata conditions. District personnel recognized that dwarf mistletoe was present in both units and could influence mangement decisions for the site. The purpose of my input and this report is to evaluate the effects of dwarf mistletoe on the units and provide options for management. The options as presented are based almost entirely on reducing the biological impact of dwarf mistletoe on their hosts.

Observations and Management

Stop #1 was a 26-acre shelterwood unit at an elevation of 7200 feet in the Lost-Walker Sale area. The stand was logged in 1986 and planted in 1990. The overstory is mostly red fir with some white fir, while the understory is a mixture of red fir and Jeffrey pine. The overstory contains 10-12 trees/acre between 20 and 40 inches DBH. A few pockets of advanced true fir regeneration, between 30 and 40 years old, were present. Jeffrey and sugar pines were scattered in the overstory of the stands surrrounding the unit.

A dwarf mistletoe was present in overstory red fir (red fir dwarf mistletoe; Arceuthobium abietinum f.sp. magnificae) and white fir (white fir dwarf mistletoe; A. abietinum f. sp concoloris). These two parasites are restricted to one host and do not cross over to other conifer species. The biology of

each pest found in the units is described at the end of this report. Severity of mistletoe infections in overstory trees, using the Hawksworth rating system, was slight to moderate for white fir and moderate to severe for red fir. A publication explaining this rating system is enclosed. Planted understory conifers (7 years old) were not infected with mistletoe, but advanced regeneration fir, 20 to 40 years old was already moderately infected. It is typical for young conifers less than 10 years old and under 4 feet tall to escape infection because they present a small target.

Alternatives for managing dwarf mistletoe in this stand are to either do nothing or to treat infected trees.

DO NOTHING:

This alternative would allow the two species of dwarf mistletoe to run their natural course. It may take decades, but with overstory sources of dwarf mistletoe seed, most of the red fir regeneration would eventually be infected. Impact data (Hawksworth, et.al., 1992) and field observations from California and Oregon true fir stands predict the following scenario. Infection of understory red fir will increase one Hawksworth rating class each 10-15 years. This means that within 60-90 years most red fir will be heavily infected (ratings of 5 or 6). Mortality during this period will exceed 50%. Measurable reductions in growth will begin after trees reach ratings of 3 and increase to 30-50% for heavily infected fir. Unmanged multistoried fir stands do not outgrow established dwarf mistletoe infestations. The only natural controls that effectively reduce dwarf mistletoe populations are stand replacing fires that eliminate both the host and pathogen (Parmeter and Scharpf, 1963).

As planted red fir become infected, they will produce mistletoe plants and seed to further the buildup and spread of this parasite. Any red fir that seeds in naturally would be exposed to infection. Although no white fir was planted, eventually any natural white fir regeneration would also be infected if white fir is left in the overstory.

TREAT DWARF MISTLETOE:

1. Removing all infected overstory red fir should be the highest priority. As stated in Hawksworth and Weins, 1966, "The opporutnity to control dwarf mistletoe is greatest at the time of final harvest and, secondly, in recently regenerated stands, 5-15 years old. The greatest dwarf mistletoe threat to regeneration exists where harvest of the previously infested stand was incomplete, and infected residual trees were left on the site". After overstory infected fir are gone, healthy understory trees will outgrow the mistletoe. The management of second growth true fir stands is based on the assumption that overstory sources of dwarf mistletoe seed have been removed (Scharpf, 1979).

2. Some uninfected or lightly infected white fir could be left in the overstory because planted red fir are not suceptible to white fir dwarf mistletoe. The Hawksworth rating system could be used to identify candidate leave trees, selecting those with the lowest rating. White fir with mistletoe ratings of 3 or more should not be left in the stand.

3. Aggregations of true fir advanced regeneration (20-40 years old) should be treated like the overstory. Infected red fir should be removed and only uninfected or lightly infected white fir retained. There is also the option of removing mistletoe by pruning if trees are only lightly infected and mistletoe plants are restricted to the lower one-half live crown.

Stop #2 was a 21-acre shelterwood unit at an elevation of 6500' with 10-15 residual trees in the overstory. The overstory was a mixture of red and white fir (16-40" DBH) with an occassional Jeffrey pine. The understory was planted with red fir and Jeffrey pine. Site class was Dunning 1-2. Growth of planted conifers was better here than at the first unit.

Red fir dwarf mistletoe was conspicuous and overstory trees were moderate to severely infected. However, we did not find any dwarf mistletoe in the overstory white fir. Advanced red fir regeneration was also infected at moderate to severe levels. Planted conifers and those that have seeded in after harvesting were all free of dwarf mistletoe plants.

While overstory Jeffrey pines were not mistletoe infected, several showed symptoms of Elytroderma needle disease, caused by the fungus Elytroderma deformans. This disease can be very conspicuous but it is rarely the cause of mature tree mortality. None of the planted Jeffrey pine had any evidence of needle disease. A unique feature of this pathogen is that it remains in infected twigs and buds from year to year and annually infects new foliage. It does not build up very quickly but once more than half of the live crown is affected, vigor is reduced and trees are more suceptible to bark beetle attacks. Small trees may be deformed and occasionally die.

Management options for the Swortzel-Kates unit:

DO NOTHING:

The do nothing alternative is the same as for Lost-Walker except that without overstory infections in white fir, future white fir regeneration is not threatened.

TREAT DWARF MISTLETOE:

1. As with the first stand, removal of dwarf mistletoe infected overstory red fir is the most important step.

2. Ensure that any white fir left in the overstory is free of dwarf mistletoe by thoroughly inspecting the crown with binoculars.

3. Control actions are rarely justified soley for Elytroderma needle disease. However, when stands are entered for other reasons, it can be beneficial to remove the most severly infected pines.

Finally, sugar pine was a component in stands adjacent to both units, as was the pathogen white pine blister rust. Sugar pine would be an appropriate

species to plant in these locations because it is not susceptible to either dwarf mistletoe found in true fir or to Elytroderma needle disease. However, the presence of blister rust means that only rust resistant sugar pine should be planted.

References

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BIOLOGIES OF PATHOGENS

Red Fir Dwarf Mistletoe

Red fir dwarf mistletoe, Arceuthobium abietinum f. sp. magnificae, is a seed-bearing plant that parasitizes only red fir. It will not survive without living host tissue, which it depends on for support, food, nutrients, and water.

Dwarf mistletoes initiate their life cycle when a seed lands on a needle or small twig of a host. The seed is coated with viscin, a sticky substance that allows it to adhere to the host tissue. During rains, the viscin becomes mucilaginous, allowing the seed to slide down to the needle base where it may lodge. The seed germinates in the winter or spring and the radicle grows along the twig until it reaches a needle base or bark irregularity. The radicle forms a holdfast and penetrates the twig into the xylem. A type of root system then develops in the twig. In 3 to 5 years from seed deposition, most successful infections will appear as branch swellings and will bear mistletoe shoots. These shoots will not produce fruit until at least 5 years following seed deposition, the average being 8-9 years. Fruit mature in the fall and disseminate seed in September and October. The seeds are explosively discharged from the fruit through the buildup of turgor pressure. Seeds normally have an upward trajectory.

Red fir dwarf mistletoe does not spread rapidly following establishment. Vertical spread in a tree averages less than 3 inches per year. Horizontal spread in a stand without overstory infection is also quite limited. The dense foliage of red fir limits spread because of the high probability of interception of the seed. Spread from infected overstory to understory may be up to about 100 feet, but it is usually less; the actual distance is dependent on slope, wind, and other factors. Trees less than 3 feet tall have a very limited chance of infection because of their small target size.

The effects of this mistletoe on tree growth and mortality relative to the Hawksworth 6-Class rating system are shown below. Source: Hawksworth, F.G., et. al., 1992. Interim dwarf mistletoe impact modeling system - users guide and reference manual. USDA Forest Service, Forest Pest Manangement, Methods Application Group, Fort Collins, CO, Report MAG-91-3, 90p.

	HAWKSWORTH DWARF MISTLETOE RATING						
	0	1	2	3	4	5	6
10-YEAR GROWTH LOSS (%):	0	0	0	2	5	30	50
10-YEAR MORTALITY (%): (trees <9" DBH)	0.0	0.8	2.8	6.1	10.5	16.2	23.1

Cytospora Canker

Cytospora abietis is a canker-causing fungus that infects true firs throughout their range in California. It is a weak parasite, and usually attacks trees that have been weakened by disease, drought, fire, insects, or human disturbance. It is most commonly associated with dwarf mistletoe infection, and sometimes attacks as many as a quarter of the mistletoe bearing branches, killing many each year. The bright red flags of recently-killed branches on dwarf mistletoe-infected red firs are almost always the result of lethal Cytospora infections. C. abietis occasionally reaches especially damaging proportions in certain years, and may attack trees of any age, sometimes killing the tops or all of young trees.

Elytroderma Needle Disease

The fungus Elytroderma deformans causes the most serious needle disease of ponderosa and Jeffrey pines in California. Occasional hosts include lodgepole, knobcone, Coulter, and pinyon pines. Unlike other needle diseases, Elytroderma infects twigs and branches systemically, allowing continued reinfection of a host's new needles even under adverse environmental conditions. Elytroderma impact is most severe in recreation forests, where the unsightly appearance of infected trees and occasional mortality can degrade the visual quality and health of a stand.

Fungal fruiting bodies (hysterothecia) release spores from infected needles in late summer and early fall. Spores are windborne to susceptible hosts and, if environmental conditions are suitable, they germinate and infect the current year's needles. Initially, the fungus grows through the needle and into the twig without killing the needle. The following spring, infected needles die and turn a conspicuous red-brown. Infected branches take on a characteristic appearance, with current year's needles looking green and healthy while the one-year-old, infected needles are bright red-brown. Long, narrow, dull black fruiting bodies form on all surfaces of the dead needles and mature later in the summer, completing the infection cycle.

Fungal mycelium within the twigs spreads into the growing tips and buds, deforming future branch growth. As a result, infected branches have a broomed appearance similar to that caused by dwarf mistletoes. However, Elytroderma brooms are distinguished by several characteristics: the red-brown color of one-year-old needles in spring and early summer; fruiting bodies scattered over the needle surface; resinous, brown necrotic lesions in the inner bark of twigs and branches infected for three years or more; and, a lack of mistletoe shoots or basal cups.

Elytroderma disease kills one-year-old needles prematurely and deforms infected twigs and branches. Generally, pines are little affected if fewer than 40 percent of the twigs are infected. The disease seldom kills mature trees directly, but moderate-to-severe infection can predispose them to bark beetle attack. The disease is most severe on seedlings, saplings, and poles that are suppressed or have thin crowns. Disease outbreaks are uncommon, but once started, the disease can persist for many years, particularly on moist sites.

White Pine Blister Rust

Blister rust (Cronartium ribicola) is caused by an obligate parasite that attacks sugar and western white pines and several species of Ribes. The fungus needs the two alternate hosts to survive, spending part of its life on 5-needled pines and the other on Ribes. The disease occurs throughout the range of sugar pine to the southern Sierra Nevada, but has not been reported further south. Infection of pines results in cankers on branches and main stems, branch mortality, top kill, and tree mortality.

Spores (aeciospores) produced by the fungus in the spring on pine bole or branch cankers are wind-disseminated to Ribes where they infect the leaves. Spores (urediospores) produced in orange pustules on the underside of the leaves re-infect other Ribes throughout the summer, resulting in an intensification of the rust. A telial spore stage forms on Ribes leaves in the fall. Teliospores germinate in place to produce spores (sporida) which are wind-disseminated to pines and infect current year needles. Following infection, the fungus grows from the needle into the branch and forms a canker. After 2 or 3 years, spores are produced on the cankers and are spread to Ribes to continue the cycle. Although blister rust may spread hundreds of miles from pines to Ribes, its spread from Ribes back to pines is usually limited to a few hundred feet.

Branch cankers continue to enlarge as the fungus invades additional tissues and moves toward the bole. Branch cankers within 24 inches of the bole will eventually form bole cankers (these are called **lethal** cankers). Bole cankers result in girdling and death of the tree above the canker. Cankers whose closest margins are more than 24 inches from the main bole are unlikely to reach the bole and only branch flagging will result (these are called **non-lethal** cankers).

Environmental conditions are critical for successful infection and limit the disease in most years. Moisture and low temperatures favor infection of both hosts, and must coincide with spore dispersal for infection to occur. In California, these conditions occur only infrequently, usually in cool moist sites such as stream bottoms or around meadows. In so called "wave years" when favorable conditions occur, high levels of infection can result. Wave years in California have occurred at approximately ten-year intervals in the past. As one moves from sites most favorable for rust to less favorable sites, the frequency of wave years decreases.